

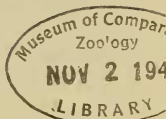
NOTES ON THE MORPHOLOGY AND TAXONOMY OF THE
GENITALIA OF THE BRITISH LEPIDOPTERA.

I.

(With Plate II.)

13,820

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The genitalia of the majority of the British species of Lepidoptera have been figured in a series of books by the late F. N. Pierce and his collaborators (Pierce, 1909, 1914, 1942; Pierce and Metcalfe, 1922, 1935, 1398; and Pierce and Beirne, 1941). The last work deals with the butterflies and the larger moths. From a study of the genitalia I arrived at somewhat different conclusions, both as to the homologies of the various parts of the genitalia and as to the relationships of the various genera and species to each other, than did Mr Pierce, who was responsible for the text of that work. My views on the morphology and taxonomy of the genitalia of the Rhopalocera have been given in a previous paper (Beirne, 1942-3); the present paper deals with some of the moths.

The text of the present paper deals mainly with the taxonomy, and the species are classified in accordance with their relationships as indicated by the genitalia. Descriptions of the morphology of the genitalia have been reduced to the minimum and have been replaced by figures. It should be noted that these figures represent the typical forms of the genitalia in each group or genus, and, unless otherwise stated, are not figures of particular species. The figures are of the side views of the genitalia with the left valve removed. References are given in the text to the appropriate plates of Pierce and Beirne on which the genitalia of the species mentioned are figured, as well as to other works dealing with the genitalia. The nomenclature used here for the parts of the genitalia is that of Beirne (1942).

SPHINGIDÆ. (Fig. 1; Pierce and Beirne, pls. VII-IX.) A rather homogeneous group. The chief variations of specific value occur in the males; in many cases the females are practically indistinguishable from each other. In the males the gnathos is usually large and strong; the valvae short and broad, each with the sacculus strongly sclerotized and with a prominent cuiller; transtillae and a juxta are usually present and the saccus is well developed. A characteristic feature of the group is that in the females the ovipositor lobes are large and heavily wrinkled. The apophyses in the female are large, the apical part of the ductus bursae is usually sclerotized, and the signa are in the form of two bands of short spines. Many of the British species are also figured by Rothschild and Jordan (1903) and by Skell (1921).

Mimas, Hübn. 1, *tiliae*, Linn.: shows close relationship to *Smerinthus*.

Smerinthus, Latr.: The combination of the hooked and pointed uncus, the triangular gnathos, the spined vesica and the bilobed cuiller appear to be the generic characters in the male, while in the female the broad and heavily sclerotized ductus and the apparent absence of a signum are characteristic. There appears to be no justification for placing the species in separate genera: the genitalia of the two are

very similar and the species are obviously very closely related. 2, *populi*, Linn. 3, *ocellatus*, Linn. (genotype).

Acherontia, Lasp. 4, *atropos*, Linn. (genotype): The only British Sphingid in which the gnathos is unsclerotized and for this reason it is rather distinct, but shows a definite relationship to *convolvuli*.

Herse, Oken. 5, *convolvuli*, Linn. (genotype): A rather distinct species but showing some relationship to *atropos*.

Sphinx, Linn. 6, *ligustri*, Linn. (genotype): A rather distinct species but showing some relationship to *atropos* and *convolvuli*.

Hyloicus, Hübn. 7, *pinastri*, Linn. (genotype): This rather distinct species has been divided into a number of subspecies by Jordan (1931), the differences resting chiefly in the relative lengths of the two arms of the cuiller. The form found in Britain is *pinastri pinastri*. The genitalia of specimens from different localities in Britain have been examined and they were all referable to that subspecies.

The next four genera, *Daphnis*, *Hippotion*, *Celerio* and *Deilephila*, are very closely related to each other, and, on the genitalia, there appears to be little reason why they are not synonymous. They are characterized by the hooked and very heavily sclerotized uncus and gnathos, by the tegumen extending around on either side to meet in the mid-ventral line below the gnathos, and by the membrane between the tegumen, gnathos and transtillae being more or less sclerotized. To the outsides of the valvae are attached large and specialized hair-scales. In the female the eighth sternum is reduced to a narrow band on either side, while the signum is in the form of a very long, straight, double band of short spines.

Daphnis, Hübn. 8, *nerii*, Linn. (genotype): A rather distinct species within the group but most closely related to *Hippotion*.

Hippotion, Hübn. 9, *celerio*, Linn. (genotype): Most closely related to *Daphnis* but also showing some affinity to *Hemaris*.

Celerio, Oken.: The only generic character appears to be the slender and pointed cuiller. The males of the three species are very similar. The females are apparently identical with each other and differ only very slightly from those of the following genus: 10, *galii*, Schiff. (genotype); 11, *euphorbiae*, Linn.; 12, *livornica*, Esp.

Deilephila, Lasp.: This genus is closely related to *Celerio*, differing mainly in the shorter and stouter cuiller. The genitalia of the two species are practically indistinguishable from each other. 13, *elpenor*, Linn. (genotype). 14, *porcellus*, Linn.

Macroglossum, Scop. 15, *stellatarum*, Linn. (genotype): The male is rather distinct but obviously closely related to *Celerio* and *Deilephila*, while the female is practically indistinguishable from females of those genera.

Hemaris, Dalm.: A rather distinct genus and the only British genus of the Sphingidae in which asymmetry of the genitalia normally occurs. The right valva (and sacculus) is always larger and better developed than the left. The spined projection of the sacculus, which is best developed in the right valva of *tityus*, is the clavus. Besides the asymmetry and presence of the clavus, other generic characters are the broad and squared saccus, the long and slender aedoeagus, the presence

of broad, flat and feebly sclerotized anellus lobes, and the split uncus. The females of the two British species are practically indistinguishable from each other. 16, *fusciformis*, Linn. (genotype). 17, *tityus*, Linn. (*bombylifformis*, Haw.).

NOTODONTIDAE. (Figs. 2-4; Pierce and Beirne, pls. IX-XI and pl. XXI.) The genitalia are often highly modified and ornamented. The males, and to a less extent the females, show strong specific characters and in many cases good generic characters, but these are often masked by the specific variations. In the male there is usually a pair of large, hairy socii, the tegumen is usually completely divided up the mid-line, the halves often being quite separate, and extends down on each side, taking the place of the lateral arms of the vinculum. The vinculum itself is consequently very much reduced, and, in most cases, there is no saccus. The eighth sternum is usually heavily sclerotized and its shape is of considerable specific value. The classification as indicated by the genitalia differs from the usual classification on a number of points. The species fall into a number of good species-groups.

Harpyia, Ochs.: The species of this genus are usually included in *Cerura* with *vinula*, but the genitalia show them to be quite distinct from that species. This genus is characterized by the beaked uncus, which has a flat, notched plate below it. The homology of this plate is doubtful; it may be the scaphium, or, more probably, it may represent the fused socii. The sides of the tegumen are very narrow, the costae and styles of the valvae are strongly sclerotized, while the remainder of each valva is more or less membranous. There is little to distinguish the genitalia of the three species from each other, the females in particular being practically identical. 1, *bicuspis*, Borkh. 2, *hermelina*, Göze. (*bifida*, Hübn.). 3, *furcula*, Linn.

Cerura, Schrank. 4, *vinula*, Linn. (genotype): A very distinct species, showing no relationship to *Harpyia*. It is apparently more closely related to *Notodonta* and allied genera.

Steuropus, Germ. 5, *fagi*, Linn. (genotype) (fig. 3): The male genitalia are very highly modified. Although very distinct, the species shows some affinity to the remaining *Notodontidae* in the presence of socii. The homologies of some of the parts of the male genitalia are obscure. The uncus is membranous but the socii are large and well-developed. The whole genitalia are withdrawn within the eighth segment, the sternum of which is produced as two large, flattened plates, from the inside of the base of which a long, heavily sclerotized arm extends up between the valvae; at either side of the eighth sternum is a patch of bristles. The valvae are small and somewhat resemble the socii in appearance.

Gluphisia, Boisd. 6, *crenata*, Esp. (genotype): A very distinct species. The male possibly shows some affinity to *Pheosia* and *Pterostoma* in the shapes of the uncus, tegumen and valvae. The uncus is very broad and flattened and is deeply emarginate at its apex. Characteristic features of the species are that the socii are absent but transtillae and a well-sclerotized scaphium are present. The female shows a definite relationship to *Pterostoma* and possibly some affinity to *Pheosia*.

Pheosia, Hübn.: The male genitalia are considerably modified, characteristic features being the great size of the uncus, socii and tegumen. Owing to the size of the tegumen the vinculum is very much reduced and is visible only as a short band on either side underneath the valva. There is a cone-shaped, sclerotized pocket between the bases of the valvae; in spite of its resemblance to a saccus its position indicates that it is probably the juxta. In general structure the male genitalia indicate a comparatively close relationship to *Pterostoma*. The aedoeagus is like that of *Ptilophora*, but this may be an instance of parallel development. The two species of *Pheosia* are very closely related to each other. 7, *tremula*, Clerck (*dictaea*, Esp.) (genotype). 8, *gnoma*, Fab. (*dictaeoides*, Esp.).

Pterostoma, Germ. 9, *palpina*, Clerck. (genotype): The general form of the male genitalia indicates a definite relationship to *Pheosia*. The female shows a relationship to *Gluphisia*. (N.B.—In Pierce and Beirne, pl. XXI, the figure of the eighth sternum of this species is inverted.)

The next six genera show close relationships to each other.

Drymonia, Hübn.: The characteristic feature of the genus is the presence of a pair of arms arising one on each side between the anellus and the base of the valva. Their homology is doubtful; they may be well-developed cristae, or, less probably, they may be the harpes or the anellus lobes. 10, *dodonea*, Schiff. (*trimacula*, Esp.): as well as showing relationship to *ruficornis* this species also seems to show some affinity to *Notodonta anceps*. 11, *ruficornis*, Hufn. (*chaonia*, Hübn.).

Notodonta, Ochs.: A rather heterogeneous genus. The genitalia do not exhibit any reliable generic characters. Three of the species, *dromedarius*, *phoebe* and *torva*, might be separated from the remainder in a distinct genus. 12, *ziczac*, Linn. 13, *dromedarius*, Linn. (genotype): This species shows definite relationships to *torva* and *phoebe*. 14, *phoebe*, Sieb. (*tritophus*, Schiff.): Obviously very closely related to *torva*. 15, *torva*, Hübn. 16, *anceps* Göze. (*trepida*, Esp.): A rather distinct species, showing little relationship to the remaining British species of the genus.

Leucodonta, Staud. 17, *bicoloria*, Schiff. (genotype): This is obviously closely related to *Notodonta*. In both sexes of this species the anterior (basal) edges of the sterna of the abdominal segments are highly pigmented and sclerotized. This pigmentation is heaviest on the segments nearest to the base of the abdomen, and is also present in *carmelita*, *plumigera* and *chaonia*.

Lophopteryx, Steph.: Characteristic features of the genus appear to be the flattened projection near the anal angle of each valva, the shape of the uncus and the reduction in size of the socii. The two species are not very closely related. 18, *cucullina*, Hübn. (genotype) (*cuculla*, Esp.): The socii are absent. 19, *capucina*, Linn. (*camelina*, Linn.) (genotype).

Odontosia, Hübn. 20, *carmelita*, Esp. (genotype): This shows a definite relationship to *Drymonia* and *Notodonta*, and is perhaps nearest to *ziczac*.

Ptilophora, Steph. 21, *plumigera*, Schiff. (genotype): A rather distinct species in both sexes. The shape of the aedoeagus might indicate

relationship to *Pheosia*, while the presence of a subscaphium further indicates relationship to that genus or to *Odontosia* or *Notodonta*.

Phalera, Hübn. 22, *bucephala*, Linn. (genotype): The male perhaps indicates a distant relationship to *Pheosia*, the female to *Pterostoma* or *Gluphisia*. In the female the ninth segment is complete and quite distinct from the ovipositor lobes.

Clostera, Samouelle: The male genitalia are very highly modified. Except for the presence of the socii this genus shows no relationship to any of the other British Notodontids, and certainly not to *Phalera*. The uncus is bifurcate and from its ventral surface arise a pair of spines, of doubtful homology. They do not represent the gnathos, because of their position, and are probably ornamentations developed in this genus only. The socii are the hairy lobes on either side of the uncus. The tegumen is produced inwards on either side ventrally as a large plate, the inner upper (*i.e.*, posterior) corner of which is produced into a short spine. The valvae are in the form of membranous, heavily wrinkled sacs. The structure is very homogeneous in the three British species, and they are obviously very closely related to each other. 23, *curtula*, Linn. (genotype). 24, *anachoreta*, Fab. 25, *pigra*, Hufn. (*reclusa*, Fab.).

The Thyatiridae (Cymatophoridae) also possess socii in the male, indicating a relationship to the Notodontidae.

SATURNIIDAE. (Fig. 5; Pierce and Beirne, pl. XIV.)

Saturnia, Schrank. 1, *pavonia*, Linn. (genotype): The uncus and tegumen are large, a clavus and a short cuiller are present, and there is no saccus. The edge of the anellus is produced into two flat, tapering arms dorsally. The aedoeagus is unsclerotized, a very unusual feature in Lepidoptera, but characteristic of this group. The genitalia of a great many species are figured and described by Bouvier (1929-1935).

ENDROMIDIDAE. (Fig. 6; Pierce and Beirne, pl. XIV.)

Endromis, Ochs. 1, *versicolor*, Linn. (genotype): The genitalia are straightforward in structure.

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REPUTED MIMICRY IN *PARERONIA VALERIA*, CR.: CONSIDERED WITH REFERENCE TO OTHER INDO-AUSTRALIAN PIERIDAE.

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To those familiar only with the "Whites" and "Yellows" of the North Temperate Zone, in which the sexes differ little in colour and black or dark markings on the upper surface are small or non-existent, a female *Pareronia*, black or dark brown above with whitish streaks and spots like some Danaiids, is a strange sight; particularly so is the form *lutescens*, Btlr., with yellow blotches in the proximal wing regions almost exactly like *Danaus aspasia*, F. It is often suggested that such apparently abnormal colours in a "White" butterfly can only be explained in terms of the mimicry theory, especially as *D. aspasia* is admittedly common and the female *Pareronia* is generally described as "quite rare."

The impression created by this apparent abnormality can, however, be corrected by analysis of the idea of rarity, by considering the systematic position of the genus *Pareronia*, and by comparative study of the coloration of the sexes in the numerous Pierid species which inhabit regions where *P. valeria* occurs, such as Malaya.

The number of Malayan species of Pieridae was given in 1934 by Corbet and Pendlebury (p. 73) as 48, and, despite various adjustments, the same number was reached by Dr Corbet in his revised list in 1942. Of these I have studied in the field and captured more than three-quarters, several of the remainder being very local or rare.

In nearly all the common species, including those of *Catopsilia* and *Eurema*, males and females are about equal in numbers, as is the case with Pieridae in such temperate countries as Britain, Canada, and Newfoundland. But in numerous Malayan Pierids Fruhstorfer (Seitz IX) and the authors mentioned described the females as very rare though the males abound in suitable localities (*o.c.*, pp. 92-3). This was my experience with a few species, such as *Appias nero* and *Hebomoia glaucippe*; however, I easily collected the supposedly rare females of *Saletara panda*, *Ixias pyrene* and *I. verna* (C. and P., 101, 102; Seitz, IX, 159). I had the pleasure of capturing the first *verna* females, and males, recorded from Malaya, and in each of the two other species my first two specimens were both females!

From 1920 onwards, under British protection, first-class, tarmac-covered highways used by motor vehicles largely replaced the old earth tracks and roads on which various animals were driven and ridden. So the beautiful crowds of butterflies, largely Pierids, which collected around seepages and the excreta of oxen and, occasionally, of elephants, became much rarer; and, as these crowds consisted largely of males, the visible disproportion between the sexes in some species has decreased, though there is no reason to think that the actual numbers diminished. Fruhstorfer mentioned these swarms as a general phenomenon in tropi-